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Indian Standard

PORTABLE EARTH RESISTANCE METER — SPECIFICATION

(First Revision)

भारतीय मानक

सुवाह्य भू-सम्पर्कन प्रतिरोधमापी — विशिष्टि

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December 1989 **Price Group 3**

Electrical Measuring Instruments Sectional Committee, ETDC 48

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards on 23 March 1989, after the draft finalized by the Electrical Measuring Instruments Sectional Committee had been approved by the Electrotechnical Division Council.

This standard was first published in 1979. The standard is revised to include various modifications in respect of construction requirements and test methods.

Earth resistance meters are employed for the measurement of the earth resistance in electrical installations, such as, in power circuits, telecommunication, domestic and industrial installations and various other electrical systems. The earth resistance meter comprises a hand-operated generator and a moving coil instrument. This standard has been drawn up to guide the indigenous instruments industry regarding the performance of such meters.

For the purpose of deciding whether a particular requirement of this standard, is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

PORTABLE EARTH RESISTANCE METER — SPECIFICATION

(First Revision)

1 SCOPE

1.1 This standard covers the requirements and tests for portable direct reading, three and four terminal earth resistance meters (hand-operated), enclosing in the same case, a generator having a rated frequency within 60 to 90 Hz and voltage in the range of 30 to 250 V for measuring earth resistance and earth resistivity, with four terminal instruments.

NOTE — The earth resistance meter is also suitable for terrain and mountainous areas for measuring earth resistance and even for places where powerful stray earth currents exist.

2 REFERENCES

IS No.	*Title*
IS 4905 : 1968	Methods for random sampling
IS 9000 (Part 2/ Sec 2 to 3) : 1977	Basic environmental testing procedures for electronic and electrical items : Part 3 Sec 2 and 3 Cold test
IS 9000 (Part 3/ Sec 1 to 4) : 1977	Basic environmental testing procedures for electronic and electrical items : Part 3 Sec 1 to 4 Dry heat test
IS 9000 (Part 5/ Sec 1) : 1981	Basic environmental testing procedures for electronic and electrical items : Part 5 Sec 1 Damp heat (cyclic) test
IS 9000 (Part 7/ Sec 2) : 1979	Basic environmental testing procedures for electronic and electrical items : Part 7 Sec 2 Impact test
IS 9000 (Part 8) : 1971	Basic environmental testing procedures for electronic and electrical items : Part 8 Vibration (sinusoidal) test
IS 9000 (Part 12) : 1965	Basic environmental testing procedures for electronic and electrical items : Part 12 Dust test

3 TERMINOLOGY

3.0 For the purpose of this standard, the following definitions shall apply.

3.1 Effective Range

The position of the scale over which the meter under reference conditions meets the specified accuracy class.

3.2 Auxiliary Earth

The spike for current supply at the time of measuring earth resistance (*see* **3.3**).

3.3 Earth Resistance

Resistance between earth conductor and earth.

3.4 Earth Spike

The spike where earth resistance is to be measured.

3.5 Acceptance Tests

Tests carried out on sample taken from a lot for the purpose of acceptance of the lot.

3.6 Potential Spike

The spike used for the connection of potential.

3.7 Rated Resistance

Resistance indicated by the meter corresponding to the full scale mark.

3.8 Rated Voltage

The open-circuit voltage of the meter between the current terminals as assigned by the manufacturer.

3.9 Routine Tests

Tests carried out on each meter to check requirements likely to vary during production.

3.10 Type Tests

Tests carried out to prove conformity with the requirements of this specification. These are intended to prove the general qualities and design of a given type of meter.

4 MEASURING RANGE

4.1 Voltage

The rated voltage for the earth resistance meter shall be in the range of 30 to 250 V.

4.2 Resistance

The preferred effective resistance ranges of the meters shall be chosen from those given below:

a) 0 to 3 Ω and its multiples of 10, and
b) 0 to 10 Ω and its multiples of 10.

NOTE — The earth resistance meter may be single range or multirange.

5 GENERAL AND CONSTRUCTIONAL REQUIREMENTS

5.1 General

The earth resistance meter shall be sufficiently robust to withstand mechanical vibrations and shocks. Its components shall be sturdy and housed in a case which shall be dust-proof and of sufficient strength to afford adequate protection against damage. The glass over the scale shall be protected by a flap. A suitable lifting handle shall be provided on the casing.

5.2 Terminals

The terminals of the earth resistance meter shall be suitably marked. The terminal knob shall be shrouded and of non-flying type.

5.2.1 The terminals shall be suitably marked as indicated below:

a) *C*, *P*, *E* (corresponding to current, potential and earth for three terminal instruments).

b) C_1, P_1, P_2, C_2 (corresponding to current and potential for four terminal instruments).

5.3 Mechanical Zero Adjustment

In the case of single coil instruments, the meter shall be provided with suitable devices, accessible from outside for adjusting the pointer to zero point on the scale.

5.4 The rotating handle of the meter shall work smoothly and shall be noiseless in its operation as far as possible. It shall preferably fold back into the casing when the meter is not used.

5.5 The friction in the moving system of the meter shall be as small as practicable.

5.6 The degree of damping of the moving system of the meter, that is, the time elapsed, till the pointer settles to a value within the permissible limits of error when a resistance of the value corresponding to an integer nearest to geometric centre of the scale is inserted between the measuring terminals under the normal conditions of use, shall not exceed 3 seconds.

5.7 Meter

The indicating meter shall be of premanent magnet moving coil type.

6 LIMITS OF ERRORS

6.1 Resistance

The error of the meter shall not exceed the value given in Table 1 under the reference conditions. The instrument shall have no effect from stray alternating current and back emf.

Table 1 Error on Measurement of Earth Resistance Testing

(*Clause* 6.1)

Type of Scale	Measuring Range (Ohms)	Tolerance
Uniform scale	0 to 1 000	± 50
	0 to 100	± 5
	0 to 10	± 0·5
Scale other than that mentioned above	Over 200 to 1 000	± 50
	Over 20 to 200	± 5
	0 to 20	± 0·5

7 ROTATION SPEED

7.1 The rotation speed of the handle at which the rated frequency is attained shall not exceed 160 rev/min.

NOTE — The rotation speed at which the upper limit of the rated frequency is attained is that speed at which the clutch ships on the generator.

8 NORMAL CONDITIONS OF USE

8.1 The meter shall be used in horizontal position, with the handle rotating at the speed given in **7.1** at a place where the external magnetic field does not influence the indication of the meter.

9 ACCESSORIES

9.1 Carrying Case

A suitable carrying case for the meter may be provided if required by the purchaser.

9.2 Spikes

The earth resistance meter shall be supplied with four galvanized spikes or 2 spikes for three terminal meter each of which shall not be less than 750 mm in length and not less than 15 mm in diameter with suitable terminal in one end and tapering at the other end, contained in a suitable carrying case.

9.3 Other Accessories

The other accessories to be supplied are as follows:

a) Reels with flexible test leads of 36 strands (the length and diameter may be decided between the manufacturer and the purchaser),

b) Hammer, and

c) Screw driver (of suitable size) or suitable device for pulling out the spikes.

10 MARKING

10.1 The following particulars shall be indelibly and clearly marked in a visible position:

a) A reference to this standard;

b) Manufacturer's name or trade-mark and serial number;
c) Rated voltage, rated resistance and speed of rotation;
d) Country of manufacture;
e) Brief instructions for using the meter (for example, precaution against external magnetic field, explanation of the device to vary the rated resistance, etc);
f) Symbol 'OADJ' for the adjusting device; and
g) Particulars as in (a), (b) and (d) above on the dial of the indicating instrument.

11 TESTS

11.1 General Conditions for Tests

Unless otherwise specified, the tests shall be carried out under the following atmospheric conditions:

Temperature	15 to 35°C
Relative humidity	45 to 75 percent
Pressure	85 to 110 kPa

11.2 Type Tests

The following shall constitute type tests:

a) Visual examination (**11.5**),
b) Insulation resistance test (**11.6**),
c) High voltage test (**11.7**),
d) Limits of error (**11.8**),
e) Errors due to vibrations in influence quantities (**11.9**),
f) Mechanical endurance test (**11.10**),
g) Dust test [IS : 2106 (Part 12) : 1965] (**11.11**),
h) Vibration test (**11.12**),
j) Bump test (**11.13**),
k) Dry heat test (**11.14**),
m) Dry cold test (**11.15**), and
n) Damp heat cycling test (**11.16**).

11.2.1 *Number of Samples and Criteria of Conformity*

Type tests shall be applied to three test specimens; in the event of any one specimen failing to comply with the requirements in any respect a further set of three specimens shall be taken, all of which shall comply with the requirements of this standard.

11.3 Acceptance Tests

The following shall constitute acceptance tests:

a) Visual examination (**11.5**),
b) Insulation resistance test (**11.6**),
c) High voltage test (**11.7**), and
d) Limits of error (**11.8**).

11.3.1 *Sampling Plan*

The recommended sampling plan and criteria for acceptance of lot are given in Annex A.

11.4 Routine Tests

The following shall constitute routine tests:

a) Visual examination (**11.5.1**),
b) Insulation resistance tests (**11.6**),
c) High voltage test (**11.7**), and
d) Limits of error (**11.8**).

11.5 Visual Examination

For type test and acceptance test purposes, the meter shall be examined for correct wiring, proper mounting of components, workmanship, finish, marking and generally for all provisions of this specification.

11.5.1 For routine test purposes, visual examination shall be done on the exterior of the instrument for checking finish of the meter, dial marking, etc.

11.6 Insulation Resistance Test

The insulation resistance of the meter across the electrical circuit and the containing case and across the electrical circuit and the handle when measured with 500 ± 50 V dc shall be not less than 25 megohms.

11.7 High Voltage Test

No breakdown, arcing or sparking shall occur when an rms voltage of the value of 2 000 volts is applied for 1 minute between the electrical circuit and the chassis.

11.8 Limits of Error

The meter shall be tested at rated voltage and under reference conditions, by comparison with a resistance box having error as half or less than that of the meter under test. The meter shall meet the requirements of **6.1**.

11.9 Errors Due to Variations in Influence Quantities

The errors due to variations of influence quantities shall be as given in Table 2.

11.9.1 *Effect of Earth Potential*

The equivalent earth voltage is applied to measuring terminals of the earth resistance meter as shown in Fig. 1 and the test shall be conducted on the effect of earth potential. The equivalent earth voltage shall be 10 V and 5 V of commercial frequency. As the test point, the central scale value shall be used for this test.

11.10 Mechanical Endurance Test

After repetition of the starting and stopping the generator with 3 seconds on and 3 seconds off for 10 000 times, there shall be no evident deterioration and impairment in the working of the meter and it shall satisfy the requirements given in **6.1**. The tests shall be done with the terminals of the earth resistance meter open.

NOTE — For the purposes of this test, starting the generator shall mean rotating the handle to attain rated speed.

11.11 Dust Test

The meter shall be kept in the test chamber for 4 hours with the atmosphere stirred and the dust shall then be allowed to settle for two hours. Details of the test shall be according to IS 9000 (Part 12) : 1965.

11.11.1 *Final Measurements*

The final measurements shall be made after the meter satisfies the requirements specified in **6.1.**

11.12 Vibration Test

11.12.1 The vibration test shall be carried out in accordance with IS 9000 (Part 8) : 1971. The vibration severities shall be as follows ·

Frequency Range	*Amplitude*	*Duration*	*Endurance Procedure*
10 to 150 Hz	0-15 mm ($2g^*$)	6 h	Endurance at resonance frequency in most unfavourable direction If direction is not known, vibration shall be applied for 2 hours in each of the three mutually perpendicular directions. If no resonance is observed, the equipment shall be subjected to vibration at each of the frequencies 25, 50, 100 and 150 Hz for ½ hour in each of the three mutually perpendicular directions so that the total duration shall not exceed 6 hours.

*g_n = acceleration due to gravity

11.12.2 After this test, the meter shall satisfy the requirements specified in **6.1.**

Table 2 Errors Due to Influence Quantities

(*Clauses* 11.9 and A-2.1)

Sl No.	**Influence Quantity**	**Permissible Deviations**
i)	Level ± 5°	Deviation of pointer not to exceed 5 percent of the value at the centre point of the scale
ii)	Ambient temperature 27 ± 2°C	Deviation of pointer not to exceed 5 percent at the centre point of the scale
iii)	Relative humidity 95 percent, 24 h	Error not to exceed limits of 6.1
iv)	Stray field*	Error not to exceed the permissible limits of error
v)	Effect of earth potential	Error not to exceed limits of **6.1**

*400 ampere turns (dc) will produce a field of approximately 0·5 m T at or near the centre of a plane circular coil of 1 m mean diameter of square section, and of radial thickness which is small compared to the diameter.

11.13 Bump Test

The bump test shall be carried out in accordance with IS 9000 (Part 7/Sec 2) : 1979. The meter shall be subjected to 4 000 ± 10 bumps at an acceleration of 400 m/s² with a pulse duration of 6 mm and at the rate of 3 bumps per second after which the error shall not exceed the values specified in **6.1.**

11.14 Dry Heat Test

This test shall be carried out in accordance with IS 9000 (Part 3/Sec 1 to 4) : 1977. The meter shall be subjected to a temperature of 55 ± 3°C for a period of 24 hours. After a recovery period of 24 hours, the error shall be within the limits specified in **6.1.**

11.15 Dry Cold Test

This test shall be carried out in accordance with IS 9000 (Part 2/Sec 2 and 3) : 1977. The meter shall be subjected to a temperature of − 10 ± 3°C for a period of 24 hours. After a recovery period of 24 hours, the limits of error shall not exceed the values specified in **6.1.**

11.16 Damp Heat Cycling Test

The test shall be carried out in accordance with IS 9000 (Part 5/Sec 1) : 1981. The number of cycles shall be two and after a recovery period of 24 hours, the error shall not exceed the limits specified in **6.1.**

ANNEX A

(*Clause* 11.3.1)

SAMPLING OF EARTH RESISTANCE METER

A-1 SCALE OF SAMPLING

A-1.1 In any consignmemt, all the earth resistance meters of the same rated resistance manufactured from the same raw material under similar conditions of production shall be grouped together to constitute a lot.

A-1.2 The number of earth resistance meters to be selected from a lot shall depend upon the lot size and shall be in accordance with col 1 and 2 of Table 3.

A-1.2.1 These earth resistance meters shall be selected from the lot at random. In order to ensure the randomness of selection, procedure given in IS 4905 : 1968 may be followed.

A-2 NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

A-2.1 The earth resistance meters selected according to col 1 and 2 of Table 2 shall be subjected to acceptance tests given in **11.3**. A lot shall be considered to be conforming to this specification if none of the earth resistance meters out of those tested fails to satisfy the requirements of any one or more of the acceptance tests.

Table 3 Size of Sample and Criteria for Conformity

(*Clause* A-1.2)

Lot of Size (1)	Sample Size (2)	Acceptance Number (3)
6 to 15	3	0
16 to 25	5	0
26 to 50	8	0
51 to 100	13	1
101 to 150	20	1
151 to 300	32	2
301 to 500	50	3
500 and above	80	4

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